in most cases. This study is particularly important to identify clearly vascular insufficiency as the basis of complaint.

Angiography should show (1) the orifices of the four major cerebral vessels to brain from aorta (carotids and vertebrals), (2) the course of these vessels in the neck through the base of the skull and (3) the intracranial circulation to indicate the entire cerebral vasculature including possible collateralization vessels supplying the areas of suspected flow impairment.

Whereas angiography *may* show intimal plaques at the origin of the carotid or vertebral arteries with implied flow impaired, it also may show an unsuspected complete occlusion of an internal carotid artery. In either case, complete study of the collateral vessels supplying the "impaired area" is then advisable. The Circle of Willis is the major source of collateral supply to the areas of the brain dependent on the major cerebral arteries. This is very important in surgical considerations and must be shown clearly. In addition, angiography should show all arteries possibly involved in collateral supply. As an example, the ophthalmic artery may bypass an occluded internal carotid; a middle cerebral artery may provide "meningeal anastomosis" to the anterior cerebral, or the reverse.

Neurosurgical vascular operations are effective in alleviating episodic cerebral vascular insufficiency syndromes and in providing further recovery of lost central nervous system function in certain RIND syndromes. Carotid endarterectomy can relieve stenotic carotid artery flow effectively and excise sources of embolization. Neurosurgical evaluation for such operations includes thorough study of collateral supply to the part of the brain involved and, in most instances, studies of involved regional cerebral blood flow by isotope (Xenon) techniques, both before and after operation. This aids in establishing not only the diagnosis but also indicates the effectiveness of the operative procedure. A carotid plaque does not necessarily need to be removed. Careful correlation of symptoms, finding and flow studies now identify a need for this procedure much better than in the past. The operation is done by vascular surgeons and neurosurgeons, but the role of neurosurgeons now is clearly broad and very effective.

Microsurgical cerebral vascular anastomoses, as now carried out by neurosurgeons, anastomose extracranial vessels to intracranial vessels. Under high magnification, such anastomoses have gained stature for superficial temporal artery (in scalp) to middle cerebral artery anastomosis in cases of internal carotid or medial middle cerebral artery obstructions. Continued neurological improvement may continue for several months after such a procedure is carried out.

Problems of basilar artery insufficiency involving loss of a vertebral artery on one side may be greatly helped by neurosurgical microanastomosis of a high cervical-occipital vessel (extracranial) to the intracranial vertebral or posterior-inferior cerebellar artery on the opposite side. Such procedures have produced increased flow in the basilar artery with pronounced improvement in symptoms.

Neurosurgical management of stroke due to obliterative vascular disease requires early recognition of the syndrome, prompt and thorough workup, and effective, complete surgical treatment. The results of this approach are improving yearly.

ELDON L. FOLTZ, MD
BRUCE A. EVERETT, MD

REFERENCES

Austin G, Laffin D, Hayward W: Physiologic factors in the selection of patients for superficial temporal artery to middle cerebral artery anastomosis. Surgery 75:861-868, 1976

Houser OW, Sundt TM Jr, Holman CB, et al: Atheromatous disease of the carotid artery—Correlation of angiographic, clinical and surgical findings. J Neurosurg 41:321-331, Sep 1974

Neck, Head and Arm Pain

COMBINED HEAD, NECK, SHOULDER (often scapular) and brachial pain usually means involvement of mixed spinal nerves in the cervical region. Although the most common cause in adults is degenerating intervertebral disc disease, physicians must recognize that entrapment processes, congenital deformations, trauma, neoplasia and infectious processes may be prominent among other conditions that can be responsible for such a syndrome. This constellation of pain requires either (1) that there be primary irritation of posterior nerve roots (or mixed spinal nerves) to an extent that includes innervation of the posterior scalp and cervical regions plus the neural supply at least to the shoulder and brachium, or (2) that there be irritation of structures that derive their innervation from such a neural distribution whereby pain may be referred into the areas noted.

Direct nerve root participation in the syndrome usually is identified by the characteristics of pain of the nerve-root origin whatever it may be: (1)

perceived in the expected territory of the known anatomical distribution of the root, (2) aggravated by postures or maneuvers which physically encroach on the nerve root including the Valsalva maneuver and (3) relieved by measures which ease mechanical distortion of the neural tissue. Problems arise, however, in assessing disease when the indirect or referred-pain mechanisms are presumed to be operative in the absence of evidence of direct neural involvement. An example in point is the inadequately supported proposal that headache, as the dominant symptom, on occasion can be attributed to C5-6 or C6-7 intervertebral disc disease and effectively treated by such operative procedures as disc excision with or without interbody fusion.

When a comprehensive history and examination exhaust the other causes of direct and primary neural involvement leaving cervical disc disease as the remaining consideration to explain the pain syndrome, the diagnostic battery of neck manipulation, plain radiological study and contrast myelography are indicated. The precise identification of the offending disc may be substantially aided by the additional use of *analgesic* discography whereby surgical procedures may be avoided upon cervical interspaces which, while possibly diseased, are not responsible for the pain.

W. EUGENE STERN, MD

REFERENCES

Roth DA: Cervical analgesic discography—A new test for the definitive diagnosis of the painful-disk syndrome. JAMA 235: 1713-1714, Apr 19, 1976

Ballantine HT: Extradural spinal cord and nerve root compression from benign lesions of the cervical area, *In* Youmans JR (Ed): Neurological Surgery. Philadelphia, WB Saunders, 1973, pp 1194-1212

Revolution in Neurodiagnosis: Computed Tomography of the Brain

COMPUTED TOMOGRAPHY (CT scan) of the brain has revolutionized neurodiagnosis as did ventriculography and pneumography in the 1920's, cerebral angiography in the 1940's and radioisotope brain scanning in the 1950's. Scanning technology is evolving rapidly to provide faster scans with finer resolution and display of the brain in coronal as well as horizontal slices. Except in showing vascular abnormalities (occlusive disease, aneurysm, arteriovenous anomaly, tumor blood supply) and lesions adjacent to the skull base (parasellar neoplasms), computed tomography has greatly diminished the use of pneumography, arteriography and radioisotope scanning. However, the occasionally false positive or negative CT scan demands that interpretation be expert and the scan be correlated with the clinical evaluation of a neuroclinician. The CT scan cannot replace the history and physical examination. In many cases the traditional neurodiagnostic studies will have to provide the diagnosis or supplement the CT scan.

The CT scan is a rapid, safe and noninvasive procedure except for uncooperative adults and children, in whom heavy sedation or general anesthesia may be required to control motion artifact. Large volume contrast enhancement risks allergic reactions.

The CT scan complements arteriography in the evaluation of the stroke syndrome since it accurately differentiates cerebral infarction and cerebral hemorrhage. However, in 20 percent of cerebral infarctions enhanced contrast occurs in the first week and they must be differentiated from a neoplasm. Hemorrhage in certain sites suggests aneurysmal bleeding and directs definitive arteriography.

The CT scan with contrast shows 95 percent of supratentorial and infratentorial neoplasms and shows tumor cysts and peritumoral edema. The scan also displays the number of metastatic cerebral lesions more accurately than other procedures. Postoperative tumor recurrence and the effectiveness of radiotherapy and chemotherapy can be ably evaluated by serial CT scans.

Earlier diagnosis of brain abscess is possible with the contrast enhanced CT scan. Serial scans follow the size of the abscess cavity and show the presence of daughter abscesses in need of drainage better than any other procedure.

The management of craniocerebral trauma is aided greatly by immediate serial CT scanning. The scan differentiates contusion and edema from intracerebral hematoma and displays the dynamic evolving pathological conditions of brain injury (multiple lesions, hematomas in the posterior fossa and frontal areas, delayed parenchymal hematomas, correctable postoperative complications) better than other diagnostic procedures. Occasionally, a subdural hematoma is isodense with brain tissue on CT scan and arteriography may be necessary to aid in the diagnosis.

The CT scan simplifies the evaluation in a neonate or infant with a large head and helps to select those patients in whom invasive diagnostic procedures are required. Serial scans display changes in ventricular size and aid in management decisions in the long-term care of hydrocephalus.